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A METHOD OF RATING FUMIGATION CHAMBERS FOR TIGHTNESS[1/]

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It is practically impossible to construct and maintain commercial fumigation chambers in a gastight condition (i.e., with respect to differential total pressure). Consequently, a portion of the fumigant leaks out during fumigations. Since the chambers are of various degrees of tightness, leakage is also variable. In extreme cases it may influence the insecticidal results.

When a fumigant is volatilized in a chamber at atmospheric pressure, a positive pressure is created, which may then be continuously reduced by leakage of the air-fumigant mixture. The time required for atmospheric pressure to be reached depends upon the tightness of the chamber. The volume of vapor required to create a given positive pressure is proportionate to the volume of the chamber. Consequently, if the time required for this pressure to be reduced to that of the atmosphere in a given chamber is equal to the time required for a similar reduction in another chamber, the volumes of air-fumigant mixture lost by leakage would be proportionate to the volumes of the chambers. These chambers would also have the same degree of tightness. This paper describes a method for rating the tightness of fumigation chambers based on these principles.

Methods and Materials

A 500-cubic-foot chamber fitted with an open-arm manometer charged with deodorized kerosene was used to establish pressure-time relationships. The temperature of the chamber ranged between 15.6° and 16.1°C. (60° and 61°F.). The temperature of the kerosene was 25°C. (77°F.), at which temperature it has a density of 0.7725 gram per cubic centimeter.

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A tube of convenient size was fitted tightly into a hole bored into the chamber. The outer end of the tube was connected with an air blower. (A vacuum cleaner contains a blower which has ideal capacity and characteristics for this purpose.) The blower was started and continued in operation until a positive pressure equal to slightly more than 50 mm. of kerosene was created in the chamber. The blower tube was then closed and the blower stopped. The pressure was recorded at 10-second intervals and the rate of leakage determined from the time required for the pressure to drop from 50 mm. to 5 mm.

To provide a measurable leakage, pipe caps with holes of various sizes (1/8 to 1 inch diameter) were attached to a 2-inch pipe entering the chamber. The ends of the pipe caps had been machined to 1/16 inch in thickness, which is the average thickness of the metal walls of fumigation chambers. Leakage from the sealed chamber was compensated for, and curves were drawn representing the relation between time and pressure for each size hole. Data from these curves are presented in table 1.

Discussion

Other gases or other temperatures will result in slightly different pressure-time relationships owing to modification of the flow characteristics of the fumigant-air mixture. At other temperatures slight differences will result from the consequent changes in density of the liquid in the open-arm manometer. It is believed that these variables need not be considered in the practical application of the method. Liquids other than kerosene may be used in the open-arm manometer, and pressure-time relationships established by calculation.

The data in table 1 may be used for comparing the tightness of fumigation chambers, whenever a desirable rate of tightness is established. Either air or fumigant-air pressure may be used in the chambers to be rated. For example, if the time required for the pressure to drop from 50 to 5 mm. of kerosene is 54 seconds, the chamber would be rated as having a tightness equal to that of a 500-cubic-foot chamber which has one 1/2-inch diameter circular hole in it. The size of a single circular hole in the rated chamber required to cause this drop in pressure in this specified time is related only indirectly to the volume of the chamber. The flow characteristics of fluids issuing from holes are affected by the size and shape of the holes, and the thickness of the diaphragm. For the same reasons the table cannot be used to measure leakage areas in chambers, as leakage usually takes place through a number of small holes or cracks.

Table 1.--Time required for air to leak through circular holes of different sizes in a 500-cubic-foot fumigation chamber

Initial pressure of kerosene[1/]	Diameter of holes										
	1/8 inch		1/4 inch		3/8 inch		1/2 inch	5/8 inch	3/4 inch	7/8 inch	1 inch
Millimeters	Min.	Sec.	Min.	Sec.	Min.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
50	16	54	4	20	1	41	54	35	22	17	12
45	15	50	4	5	1	35	51	33	21	16	12
40	14	51	3	49	1	28	47	31	20	15	11
35	13	36	3	41	1	21	43	28	18	14	11
30	12	16	3	12	1	13	39	25	16	12	10
25	10	40	2	50	1	4	34	22	14	11	9
20	8	50	2	24		54	28	18	11	9	7
15	6	49	1	53		41	20	13	8	7	6
10	4	24	1	14		24	12	7	5	4	3

[1/] Final pressure = 5 mm. of kerosene.

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Experimental chambers used for the establishment of dosage-time-temperature schedules are generally classed as being nearly gastight. One of these chambers rated by this method was found to have a tightness equivalent to that of a 500-cubic-foot chamber with a circular hole a little over 1/4 inch in diameter. A few commercial chambers have been rated by this method. One was tighter than the experimental chamber, but most of them were less tight although largely within the range in table 1. Since the maximum of this range represents a leakage area of less than 1 square inch in a total surface of at least 54,430 square inches, it may be considered that chambers within the range are relatively tight.

In general, the method described is an adaptation of the airtight room test (2, p.155) one of the established methods of testing fans. As applied by Durley (1), air is allowed to discharge from the room through circular orifices in thin plates. This method is now being used for testing the tightness of fumigation chambers employed in connection with the Japanese beetle quarantine.

LITERATURE CITED

(1) Durley, R. J. 1906. On the measurement of air flowing into the atmosphere through circular orifices in thin plates and under small differences of pressure. Amer. Soc. Mech. Engin. Trans. 27: 193-231.

(2) Liddell, D. M., Ed. 1922. Handbook of chemical engineering. Vol. 1. New York and London.